ELECTRONIC BOOM HEIGHT SENSOR

Field of the Invention

[0001] The invention relates to boom operation on work vehicles such as, for example, loaders. It relates to a simple and inexpensive system and method of improving the safety, comfort, accuracy and repeatability/consistency in boom operation.

Background of the Invention

[0002] On many work vehicles such as, for example, loaders and backhoes, the heights and angles of the work tools must be visually estimated and manually adjusted on a somewhat constant basis. This will quickly lead to fatigue for a normal human operator. On other work vehicles, a few positions, i.e., heights and angles, of the work tools are factory preset allowing the work tools to be automatically placed in those positions at the direction of the operator via a simple pushing of a button, a manipulation of a handle or some other simple operation. On still other work vehicles, kickout positions for the work tools may be programmed and modified by the vehicle operators from without or within the cab. However, the adjustment methods and/or mechanisms appear to be complex, cumbersome and/or expensive as they require sensor systems with complex linkages and/or adjustments by vehicle operators outside of the operator cab.

Summary of the Invention

[0003] The inventors recognize that conventional boom height sensing and adjustment mechanisms are somewhat cumbersome and/or expensive and have determined that such is unnecessary. They have invented a simplified method of tracking the position of a boom for a work vehicle. The method uses a height or angle sensor of very simple design which comprises a spring loaded follower arm biased such to constantly exert pressure against the boom at all boom positions. Thus, the follower arm rotates as the position of the boom changes and causes a change in electrical potential across an electromechanical device such as, for example, a potentiometer. This change in electrical potential is fed to a signal processing device or onboard computer such as, for example, a chassis control unit and the operator. After electronically sensing the boom position, it is possible to set

kickout positions, return to dig positions and/or return to carry positions from the cab with a mere push of a button or operation of a switch at desired boom heights. A boom manipulating control lever, used by the operator to manipulate the boom from within the cab normally has at least one detent or locked position. The boom may be automatically set to move to a set/stored position by moving the control lever to the detent position. Once the boom reaches the position associated with the stored signal the chassis control unit sends a signal to release the control lever from the detent position and allows it to return to a neutral position. Thus, the movement of the boom stops upon release of the control lever.

[0004] The system is extremely simplified and does not require a linkage system between the sensor and the boom as in conventional systems. Thus, the sensor is capable of being attached with a minimum of modifications to the work vehicle as it is merely rigidly affixed to a portion of the vehicle and connected via electrical cable or wirelessly to the height estimating device. Conveying the position data to the chassis control unit may be accomplished through a flexible electrical cable or wirelessly via electromagnetic waves.

Brief Description of the Drawings

[0005] Embodiments of the invention will be described in detail, with reference to the following figures, wherein:

Fig. 1 is view of a work vehicle in which the invention may be used;

Fig. 2 is an oblique view of an exemplary embodiment of the assembled invention showing the boom in a heightened or kickout position;

Fig. 3 is a side view of the embodiment illustrated in Fig. 2;

Fig. 4 is a side view of an exemplary embodiment of the assembled invention showing the boom in a lowered or return position;

Fig. 5 is a rearward view of the sensor;

Fig. 6 is a frontal view of the sensor;

Fig. 7 is an exploded view of the sensor; and

Fig. 8 is an exemplary embodiment of a functional diagram of the invention.

Detailed Description

[0006] Fig. 1 illustrates a work vehicle in which the invention may be used. The particular work vehicle illustrated in Fig. 1 is an articulated four wheel drive loader having a main vehicle body 10 that includes a front vehicle portion 100 pivotally connected to a rear vehicle portion 200 by vertical pivots 220, the loader being steered by pivoting of the front vehicle portion 100 relative to the rear vehicle portion 200 in a manner well known in the art. The front and rear vehicle portions 100 and 200 are respectively supported on front drive wheels 101 and rear drive wheels 201. An operator's station 210 is provided on the rear vehicle portion 200 and is generally located above the vertical pivots 220. The front vehicle portion 100 includes a mast 120 having a right mast portion 120a and a left mast portion 120b. The front and rear drive wheels 101 and 201 propel the vehicle along the ground and are powered in a manner well known in the art.

[0007] Mounted on the front vehicle portion 100 is a boom 110 that is partly formed by first and second boom arms 110a and 110b respectively. The first and second boom arms 110a and 110b are connected by a transverse cross tube 111 that is welded to each of the first boom arm 110a and the second boom arm 110b. The rear end of the boom 110 is connected to the mast 120 by transverse pivots 125 and a loader bucket 115 is mounted on the forward end of the boom 110 by transverse pivots 116. The boom 110 is rotated about the transverse pivots 125 by hydraulic lift cylinders (not shown).

[0008] Fig. 2 illustrates an exemplary embodiment of a boom position sensing device 300 of the invention mounted to the mast 120. In this particular embodiment, the sensing device 300 is mounted to a side wall 121 of the mast 120 via screws 301. In this particular embodiment, a spring loaded follower arm 312 is biased against the underside of the first boom arm 110a such that the follower arm 312 exerts pressure against the first boom arm 110a at all rotational locations. Thus, as shown in Fig. 3 and Fig. 4, the spring loaded follower arm 312 of this embodiment contacts the underside of the boom 110a at all points of rotation for the boom 110 without the necessity of a physical attachment to the boom 110 and the accompanying complexities associated with such an attachment.

[0009] Fig. 5 illustrates an exemplary embodiment of the boom position sensing device 300 of the invention. As shown in Fig. 5, the boom position sensing device 300 includes a body 309, a follower assembly 310 and a potentiometer assembly 306.

[0010] The body 309 includes a first body portion 302 and a second body portion 303, the first and second body portions 302 and 303 being rigidly connected to each other via bolts 304a and locknuts 304b. The first body portion 302 includes a L channel portion 302a and a C channel portion 302b. The L channel portion 302a contains two holes 301a for attaching the entire boom position sensing device 300 to the outer wall 121 of the mast 120 via bolts 301. It also contains two holes 304a for attaching the first body portion 302 to the second body portion 303 via bolts 304a and locknuts 304b. The C channel portion 302b contains two holes 307a for attaching a potentiometer assembly 306 via locknuts 306e and bolts 306c and a third hole 306j to allow the passage of shaft 316 through the wall of the C channel portion 302b and into the potentiometer 306b. Finally, the C channel portion 302b contains an anchor bolt hole 320a for attaching a spring anchor bolt subassembly 320.

[0011] The second body portion 303 contains two holes 304b for attaching the first body portion 302 to the second body portion 303. The second body portion 303 also contains two additional holes 315a and 316a. Attached to the second body portion at holes 315a is a stop assembly 315 to restrict rotational motion on the follower arm 312. Press fitted into the hole 316a and toward a first end of a shaft 316 of the follower assembly 310 is a shaft bushing 310a to enhance rotational movement of the shaft and to restrict axial movement of the spring bushing 318. Washers 317 are placed along the shaft 316 on either side of the spring bushing 318, a first end of the follower arm 312 is press fitted onto the shaft at a position next to the spring bushing 318, and a snap ring is assembled to a snap ring groove 316a toward a second end of the shaft 316 to hold all of the washers 317 and the spring bushing 318 in place as well as to restrict axial movement of the shaft 316. A first end of torsional loading spring 314 is anchored to spring anchor 320 while a second end of torsional loading spring 314 constrains and biases the follower arm 312 against the underside of the first boom arm 110a. Attached to a second end of the follower arm 312 is a roller

assembly 313 which includes a roller wheel 313a and bushing 313d as well as a roller bolt 313b and a locknut 313c to restrict all motion of the roller wheel 313a and the bushing 313d relative to the roller bolt 313b excepting rotational motion.

[0012] The follower assembly 310 includes the follower arm 312, the torsional spring 314, the shaft 316, the shaft bushing 310a, the plurality of spacers 317, the snap ring 330, and the spring bushing 318.

[0013] Attached to the C channel portion 302b is a sensor or potentiometer assembly 306 which includes a bracket portion 306a and a sensor portion or potentiometer 306b. The bracket portion 306a and the potentiometer 306b are attached to opposite sides of a C channel wall 302c via bolts 306c, washers 306d and locknuts 306e. On assembly of the potentiometer assembly 306, rubber washers 302f are placed between the C channel wall 302c and the potentiometer 306b as a seal against the environment. On assembly of the entire boom height sensing device 300 the second end of the shaft 316 protrudes through a hole 306g in the bracket portion 306a and into a hole 306h in the potentiometer 306b where it is keyed in a well known manner to a conventional rotor in the potentiometer 306b such that a change in the angle of the shaft 316 results in a proportional change in the potential across the potentiometer 306b.

[0014] As illustrated in Fig. 8, the detected signal from the boom position detector 300 is transmitted to the chassis control unit 500 via electrical wire or wirelessly through electromagnetic waves. The first rocker switch 601 and the second rocker switch 602 are activated with a push. Subsequent to activation, the operation of the first rocker switch 601 and/or the second rocker switch 602 sends a momentary signal to the chassis control unit 500 which causes the chassis control unit 500 to record the current signal value from the boom position detector 300. The chassis control unit 500 then compares the recorded signal from the signal recorder 510 and the detected signal from the boom position detector 300 and sends a signal to unlock the control lever 700 from the detent position when the recorded signal is approximately equal to the detected signal. The chassis control unit 500 is capable of storing additional detected signal values, i.e., after storing a value for the first rocker switch 601, it may store an additional value for the second rocker switch 602.

Thus, boom kickout values and return to carry values may coexist in the chassis control unit increasing the convenience and ease of operation of the work vehicle.

[0015] Having described the illustrated embodiment, it will become apparent that various modifications can be made without departing from the scope of the invention as defined in the accompanying claims. For example, it is possible for a dial in potentiometer or a digital device with a position readout to be calibrated to the potentiometer 306b such that the position could be dialed or typed in by the operator prior to placing the boom in that position.